

they are always pigmented either by a diffuse fluid "retinal purple," or by pigment in granules, or both.

In both these particulars the retinulae of Arthropoda resemble the nerve-end cells of other animals.

It is hardly necessary to point out that Leydig, Max Schultz, Grenacher, and many others, have traced the optic nerve fibrils to the retinulae. I have in my possession several series of preparations showing this both in insects and Crustacea, and any one can readily see this for himself by making even clumsy sections through the eye of *Squilla*.

In Fig. 1 I have figured the nerve fibrils of the eye of *Squilla* perforating the basement membrane and entering the retinulae, and in Fig. 2 a transverse section through the rhabdom and retinulae showing their relative position and numbers.

A special feature of the retinula is that it is always pigmented. In specimens hardened in spirit a granular pigment may be seen in the retinula cells, which is usually of a light-brownish colour and very unevenly distributed (Fig. 2). But in addition to this granular pigment, the retinulae contain a true retina purple, which fades upon exposure to the light. This was discovered in 1864 by Leydig<sup>1</sup> in the following genera of Insecta:—*Procrustes*, *Scarabaeus*, and *Pieris*, and in *Astacus* among the Crustacea. I have also seen it in *Musca vomitoria*, and have now no doubt that it exists in the Arthropod eye generally.

So far, then, I think it must be admitted that both anatomical and physiological considerations tend to prove that the retinula is the nerve-end cell of the Arthropod eye.

When we turn to morphology, too, we have confirmatory evidence that this is the case.

In the ocellus of the water-beetle larva the retina is a simple cup of pigmented hypodermis cells, in which the optic nerve fibrils may be readily seen to terminate. These cells are most certainly homologous with the retinula cells of the so-called "compound" Arthropod eye, as has been already shown by Grenacher in his important treatise, "*Untersuchungen über das Sehorgan der Arthropoden*" and elsewhere, and confirmed by the more recent researches of Lankester and Bourne upon the eyes of *Limulus* and the scorpions.

The researches of Claparède and Weismann on the development of the eye of Arthropods confirms the deductions of morphology, by proving that the cells which ultimately form the retinulae are specially modified hypodermis cells, and at an early stage come into connection with optic nerve fibrils. If any further evidence were required to confirm this homology it can be readily obtained by studying the eyes of very young cockroaches, in which the retinulae at the periphery of the eye are formed from specially modified and deeply pigmented hypodermis cells.

But it is tedious and unnecessary bringing evidence of this kind to confirm a theory which is already fully established in the minds of most naturalists. In fact we have here an instance in which morphology, physiology, comparative anatomy, and development combine to establish an homology, and consequently we must definitely assert that the retinulae are the nerve-end cells throughout the Arthropoda. But what is the meaning of Lowne's bacillar layer behind the basilar membrane? and does it exist in all Arthropods?

It is perfectly true that behind the basilar in many Diptera, Coleoptera, Lepidoptera, and Hymenoptera there is a layer composed of a number of small cylindrical masses which has a superficial resemblance to the rods of the Vertebrate eye, but Mr. Lowne did not discover this layer in any sense of the word, for it was perfectly well known to Leydig, who figured it in *Formica rufa*, *Dytiscus marginalis*, and *Sphinx ligustri* (vide Leydig's Tafeln,

viii. ix. x.). The little cylindrical masses cannot be regarded as cells, nor rods, nor bacilli, for each one of them is composed of a very fine reticulum of nerve fibrillae which is in direct communication with the optic nerve fibrils behind, and the terminal anastomosis of the optic nerve fibres in front. In fact, these "bacilli" of Lowne are connected with nerve fibrils on both sides, and thus differ from "nerve-end cells" in one of their two fundamental characters.

Very often, too, this layer is quite devoid of any pigment (*Apis*, *Eristalis*, *Bombyx*, *Squilla*, &c.), and no one has ever yet been able to demonstrate the presence of retina purple in this region.

Another important difficulty in the way of accepting this theory, too, is the fact that this layer is not always present (*Periplaneta*, *Nepa*), and in all Crustacea and many insects it cannot be divided into separate bacilli.

I have lately paid considerable attention to this part of the optic tract, but must defer a fuller explanation of the meaning of it until I am able to publish my paper in the *Quarterly Journal of Microscopical Science*, when I shall be able to illustrate my researches by several figures. To summarise, however, the evidence against this layer being composed of nerve-end cells: We find that it is certainly not homologous with the retina of other animals; optic nerve fibrils both enter and leave it; it is devoid of retina purple or of any other form of pigment in many Arthropods, and finally it is absent as a bacillar layer in many insects and in all Crustacea. In fact we can bring as much evidence to prove that this is not the retina as we can to prove that the retinulae are the true nerve-end cells.

At the conclusion of his paper Mr. Lowne says, in referring to a recent memoir of Justus Carrière of Strassburg, "He remains, however, a disciple of established views, and has not given the retinal layer nearly so much attention as it deserves." I have given the retinal layer as "much attention as it deserves," and must also claim to remain a "disciple of established views."

SYDNEY J. HICKSON

## RORAIMA

A TELEGRAM has been received at Kew giving the welcome news that Mr. Everard F. im Thurn has at last ascended Roraima. This has been the cherished object of botanical exploration in South America for the last quarter of a century. The expenses of Mr. im Thurn's expedition have been borne in equal shares by the Government grant of the Royal Society and the Royal Geographical Society.

The latest news from Mr. im Thurn was in a letter dated December 6 from the south side of the mountain, and the following passage describes the position immediately before the final attack:—

"Before we came to Roraima itself we had four days walking through a purely savannah, but most glorious country, and over splendid mountain passes, guided by an Arecoona who said, villain that he is, that he knew the way to Roraima. But at a village marked on the map as Ipelemonta, on the Aroopa River, and with a considerable mountain pass still between us and Roraima, our villain guide at last admitted that the road for some distance had been quite new to him, and that he now knew not how to proceed further. However, at last we procured a guide, and came, in some four hours, out of our difficulties at Ipelemonta (its real name, by the way, is Toorarking), into this inconceivably magnificent valley, and are installed in a village on the actual southern slopes of Roraima itself.

Yesterday Perkins and I ascended the slope of Roraima to a height of 5600 feet to a most beautiful spot—a very garden of orchids and most beautiful and strange plants. To-morrow, after despatching the bearer of this scrawl, we

<sup>1</sup> Leydig, "Das Auge der Gliederthiere." Tübingen, 1864.

go up to the same place with a lot of Areconas, who are to build us a house, in which we intend to stop for a week or as much longer as we may find desirable. I may mention that we have already seen, close to where our house is to be, a place where the mountain *seems* accessible; but it looks so easy that I am convinced that it is impossible at that point."

#### BENJAMIN SILLIMAN

DURING the American War of Independence many men were called on to leave peaceful pursuits and adopt the profession of arms. Among these men was a well-known lawyer of New Haven in Connecticut, Gold Selleck Silliman by name. Lawyer Silliman became Brigadier-General Silliman. As the British troops advanced in the direction of New Haven the family of the General left their native place and settled in North Stratford, now called Trumbull. In this town Benjamin Silliman, the father of him whose death was recently recorded in these columns, was born in 1779.

Benjamin Silliman, sen., was a central figure in the group of pioneers of natural science in the United States. In 1818 he commenced the *American Journal of Science and Arts*, which continues to the present day to hold a leading position among the scientific journals of America. Two years before this date—that is, in 1816—Benjamin Silliman, jun., was born, at New Haven, where the Silliman family had so long had their home. The younger Silliman graduated at Yale College in 1837; and in the following year he began to teach chemistry, mineralogy, and geology. In 1846 he was appointed Professor of Applied Chemistry in the Sheffield Scientific School in connection with Yale College. The scientific work of Benjamin Silliman seems to have fairly begun about this time; according to the Royal Society's Catalogue, his first paper, "On the Use of Carbon in Grove's Battery," was published in 1842. From that time until his death he was an active worker in the advancement of science. During the years 1849-54 Silliman was Professor of Toxicology in the University of Louisville, Kentucky; in the latter year he returned to Yale College, to succeed his father as Professor of Chemistry. Here he remained until January 13 last, when he "went over to the majority."

Prof. Silliman did not publish any original memoirs, involving experimental work, of first-rate importance; like his father, he was distinguished rather as an organiser and teacher than as an investigator. For many years he acted as Secretary and Editor of the *Proceedings* to the American Association for the Advancement of Science. In 1838 he became associated with his father as joint editor of the *American Journal of Science*; in this capacity he exercised a great and beneficial influence in all matters connected with natural science in his own country.

The journal of which Silliman was an editor contains about seventy papers from his pen; the greater number deal with mineralogical or chemico-mineralogical subjects, but he also wrote on such topics as glacier-motion, Australian wines, petroleum, temperature of flames, &c. He likewise furnished the *Journal* with many reviews of books and reports on the progress of various branches of natural science.

He published a book on the "First Principles of Chemistry," and another on the "Principles of Physics."

In his capacity as a public lecturer on scientific subjects, Silliman helped to guide the general opinion of his fellow-citizens in these matters in the right direction. It may indeed be said that his life-work was to form a connecting link between those who had devoted themselves to original investigation in natural science and the general outside world, which, while interested in science, requires a judicious and trustworthy middleman to interpret the

meaning of the work that is being done for humanity by the students of nature in the inner shrine.

M. M. P. M.

#### MASAI LAND<sup>1</sup>

M. R. THOMSON has not kept us waiting long for the story of his journey through a region of Africa which, so far as is known, had not previously been visited by any white man. Kilimanjaro itself was seen for the first time by Rebmann. After him Krapf, New, Von der Decken, Hildebrandt, and Wakefield, penetrated to the borders of the region which has been explored by Mr. Thomson, New alone being able to reach the snow-line on Kilimanjaro. Kenia, though doubtfully sighted by Krapf from afar, had never been approached. Mr. Thomson had thus a virgin field before him when he arrived at Zanzibar in the beginning of 1883, and the enterprise intrusted to him by the Royal Geographical Society he carried out in a manner and with results that will add much to the reputation which he achieved on his first expedition to Tanganyika. Mr. Thomson's instructions were to ascertain if a practicable direct route for European travellers exists through the Masai country from any one of the East African ports to Victoria Nyanza, and to examine Mount Kenia; to gather data for constructing as complete a map as possible in a preliminary survey; and to make all practicable observations regarding the meteorology, geology, natural history, and ethnology of the regions traversed. These objects Mr. Thomson never lost sight of, and, considering the means at his command, the time at his disposal, and the black-guardly crew he had to be content with as followers, are even more than might have been expected. Mr. Thomson is first of all a geologist, and no region in Africa is of more interest from a geological standpoint. He knows, moreover, enough of natural history to enable him to observe the flora and fauna of a country intelligently, and the value of his botanical collections has already been pointed out in our pages by Sir Joseph Hooker. For geographical observations he was even better fitted than in his previous expedition, and as for ethnology he found himself among a people unlike anything he had ever heard of in Africa, and in whom he took the intensest interest. Thus for the scientific reader the volume abounds with interest, and, as Mr. Thomson has no end of hunting and other stories of adventure to tell, his book is sure to be popular, especially as he is a skilful storyteller, abounding with a strong feeling of humour, or at least for the ludicrous, which does not spare even himself.

Mr. Thomson's route lay westwards from Mombassa to Kilimanjaro, which he traversed on nearly every side. Here he stayed for some time, ascending a considerable distance towards the Kimawenzi summit. For this magnificent mountain is really double-peaked, the highest summit, Kibo, reaching a height of over 18,610 feet, and Kimawenzi only about 2000 feet lower. The scenic features of the mountain were described in some detail in our columns recently in the paper read by Mr. Johnston at the Geographical Society, in which also its botanical and zoological characteristics were well brought out. Kilimanjaro, Mr. Thomson tells us, may be described as a great irregular, pear-shaped mass, with its major axis in a line running north-west and south-east, the tapering point running into the heart of the Masai country. On this line it is nearly sixty miles long. Its minor axis, running at right angles, reaches only to some thirty miles. The mountain is divided into the great central mass of Kibo and the lower conical peak of Kimawenzi. Towards the north-west it shades away into a long ridge, which gradually tapers horizontally and vertically till it becomes

<sup>1</sup> "Through Masai Land; a Journey of Exploration among the Snowclad Volcanic Mountains and Strange Tribes of Eastern Equatorial Africa." By Joseph Thomson, F.R.G.S. (London: Sampson Low and Co., 1885.)